Reinhold Environmental Ltd.

2008 APC Round Table & Expo Presentation

July 13-15, 2008, in Savannah, GA

Work in progress:

The most active work, at the moment, centers around dual injection of mitigating chemical at more than one location. Combinations most in play are:

- Pre AH Ca injection
- Pre AH Na injection
- Pre SCR Na injection with post SCR polishing
- Furnace Mg injection with post SCR polishing,
- Furnace Mg injection with pre and post SCR polishing

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What is the right Solution?

Remember, there is no straight path to correct gas chemistry,

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NOx Reduction/NH_3 Control

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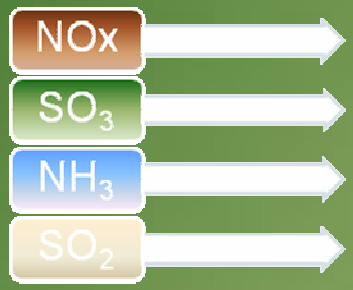
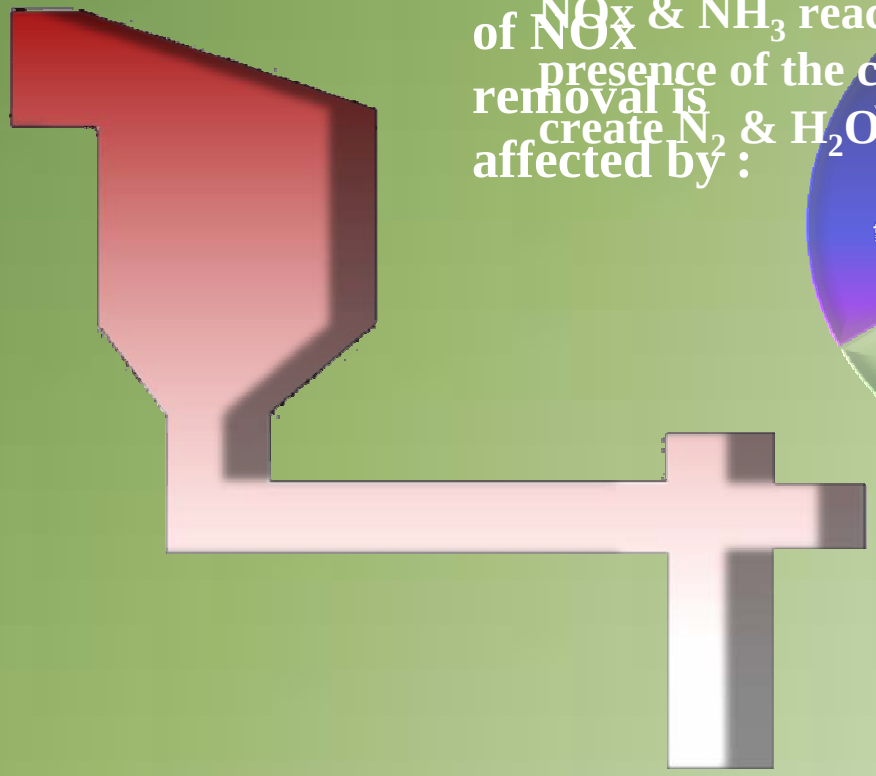
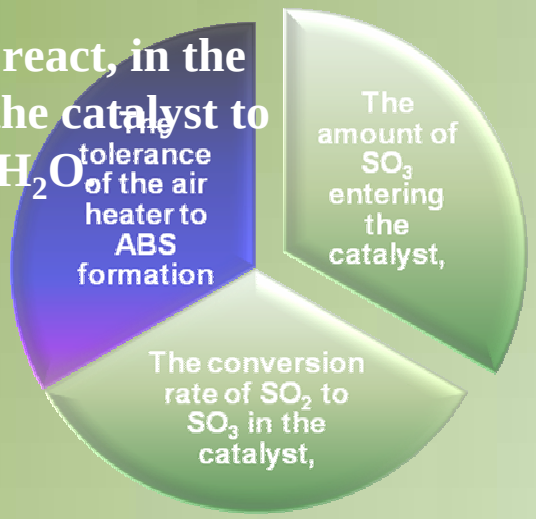
Integrated NO_x Control





The total level of NOx removal is affected by :



- NO_x & NH_3 react, in the presence of the catalyst to create N_2 & H_2O.

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Effects of SCR Inlet SO_3

For a fixed NH_3 flow rate:

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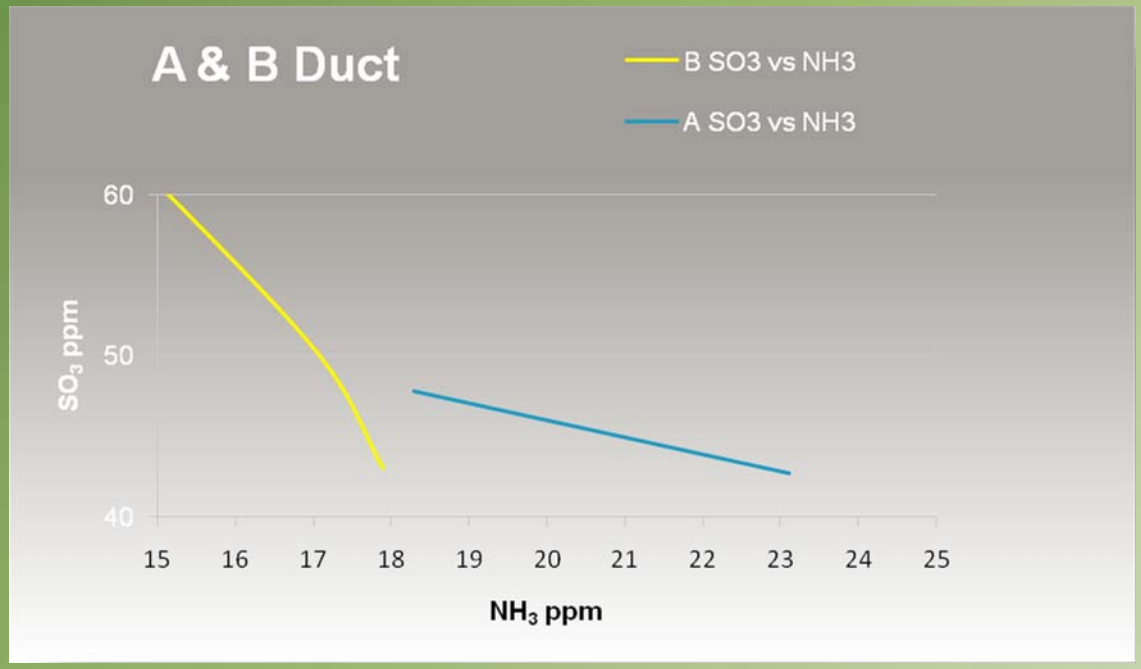
But where do NH_3/SO_3 combine and what happens in the catalyst



At Duct Temp of 650F ABS Vapor may have already formed

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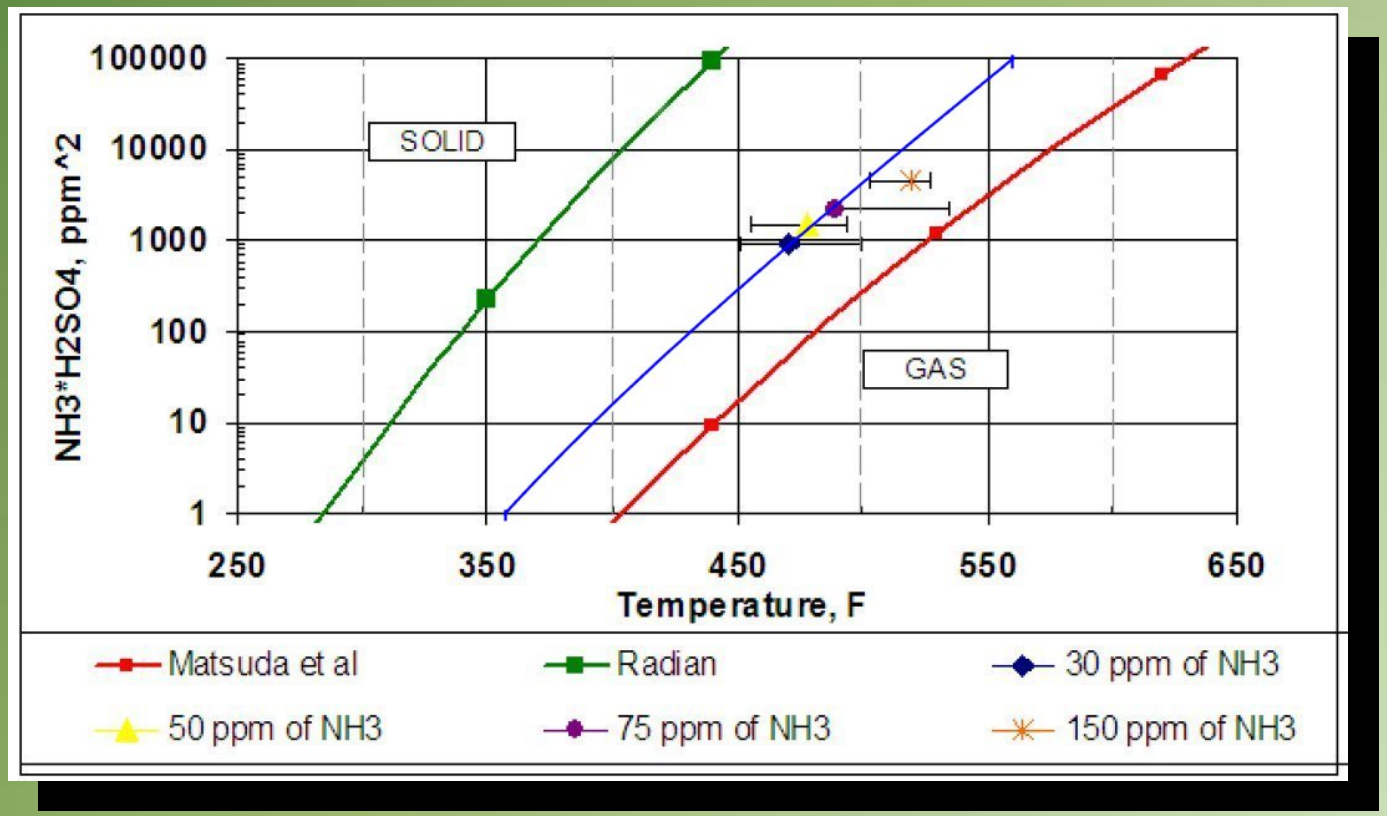
UCI Work NH_3*SO_3 Multiple



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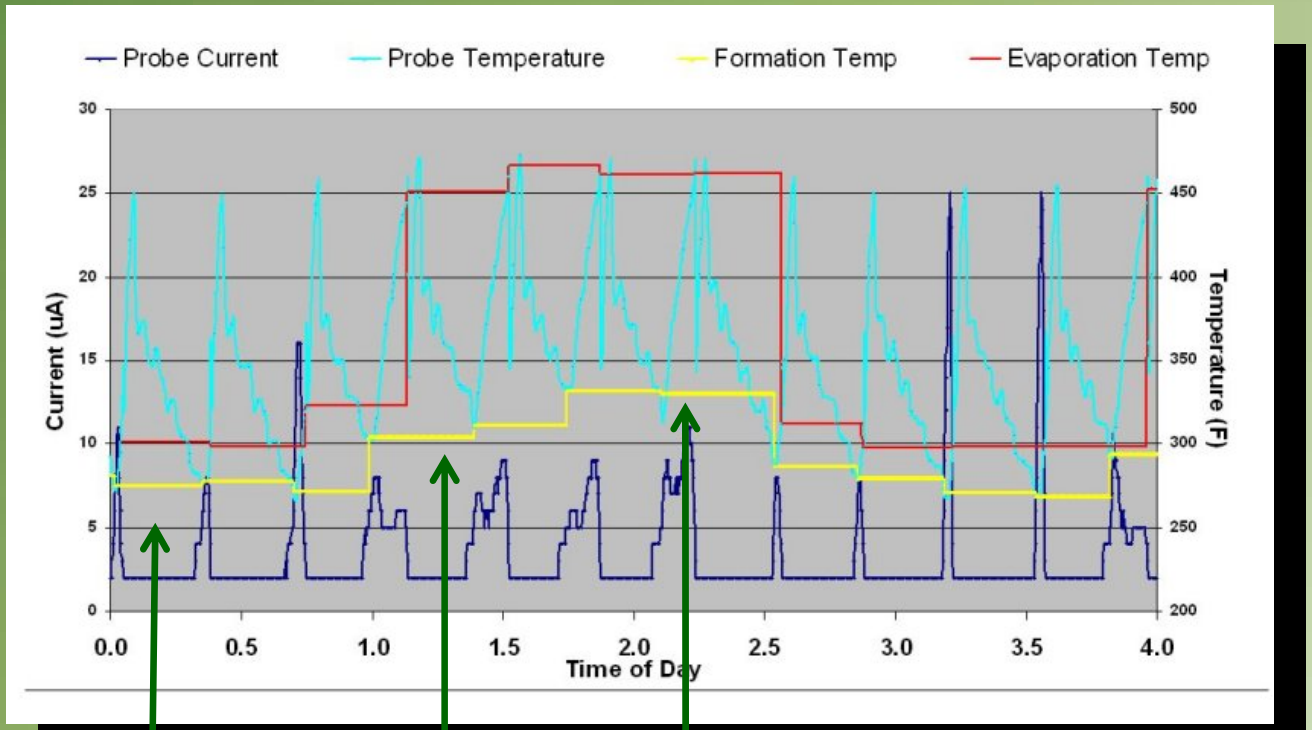
Sensory Control of NH3 Flow



Insufficient NH_3

Optimal NH_3

Excess NH_3

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Work in progress:

Ongoing work suggests that the level of SO_3 present at the SCR inlet influences compounds formed in the catalyst:

- High Inlet SO_3 may lead to high ABS and compromised NOx reduction,
- Low inlet SO_3 may aid NOx reduction in four ways:
  - NH_3 reacts with NOx rather than SO_3 in the early catalyst layer,
  - NH_3/SO_3 ratio favors AS rather than ABS in the early catalyst layer,
  - Any ABS formation will be of a lower concentration due to a lower NH_3*SO_3 multiple,
  - Reduced risk of ABS, and lower ABS vapor concentrations allow a lower SCR minimum operating temperature

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Integrated NH_3/SO_3 Control

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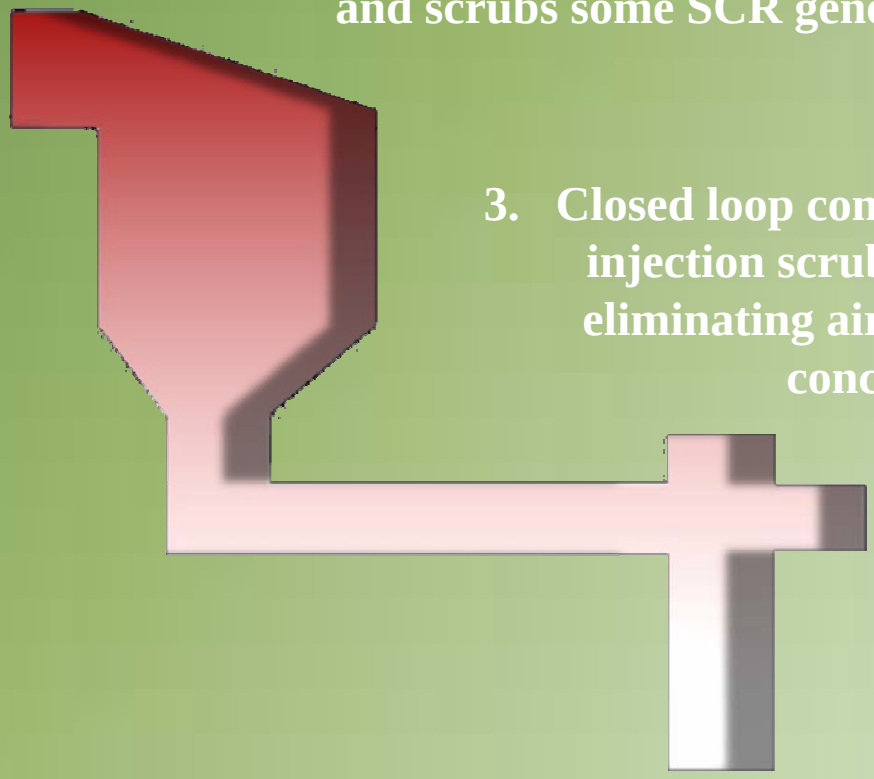
Integrated NH_3/SO_3 Control

1. **Control of SO_3 ahead of the SCR to 1 ppm through closed loop control of the pre-SCR injection process**

2. **Aggressive NH3 injection in the presence of reduced inlet SO_3 improves marginal NOx performance and scrubs some SCR generated SO3.**



3. **Closed loop control of post SCR injection scrubs residual SO_3 eliminating air heater fouling concerns.**

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Pre-SCR Injection Only

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Pre & Post SCR Injection

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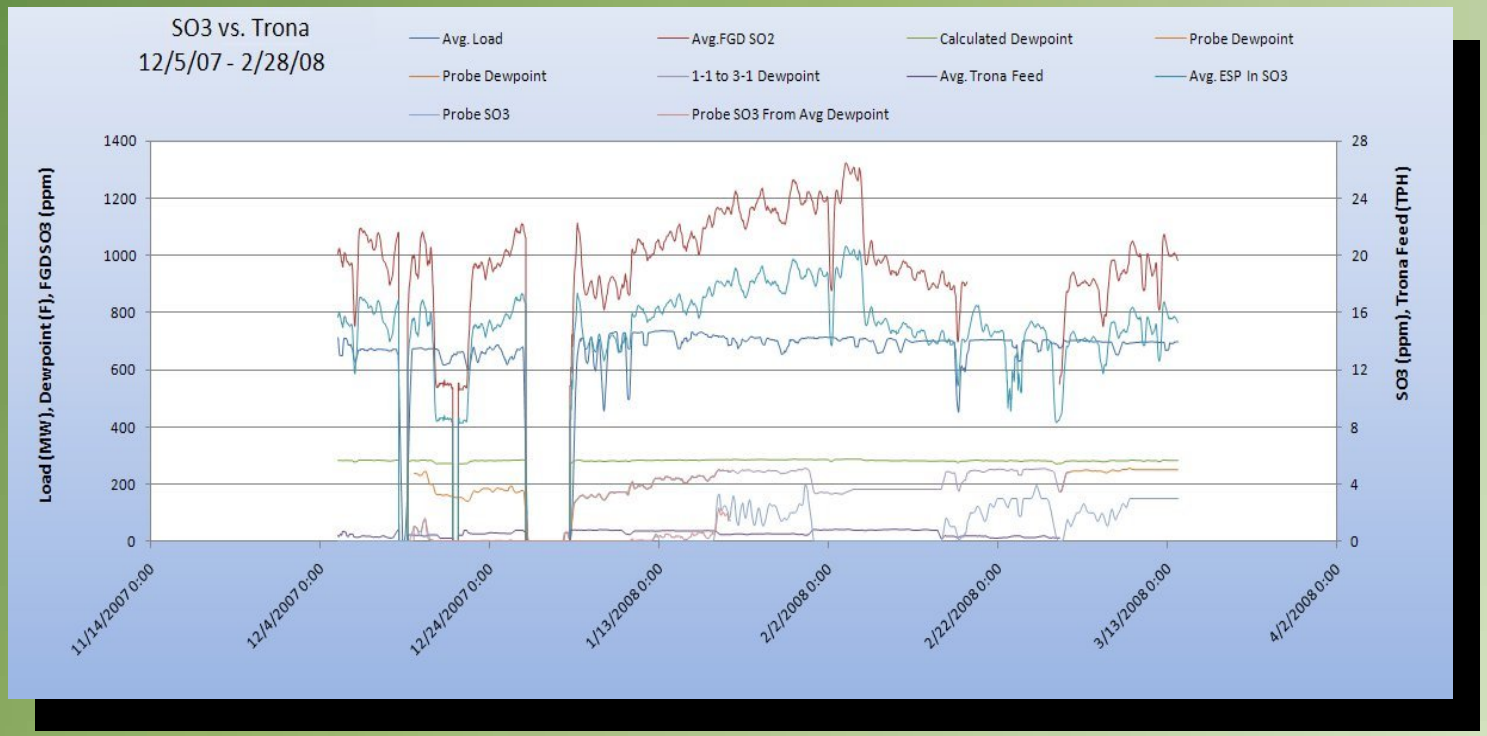
Post AH Injection for Blue Plume

- Closed loop control for the purpose of commercial cost control is easy and effective



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Dynamic Air Heater Cleaning

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Air Heater Sootblowing

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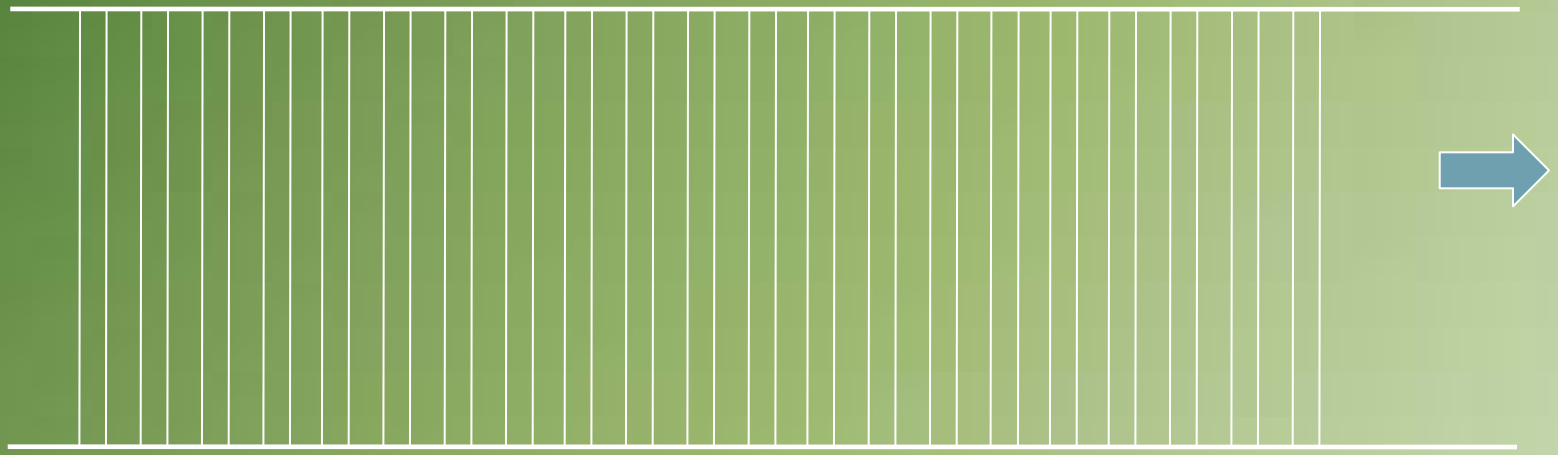
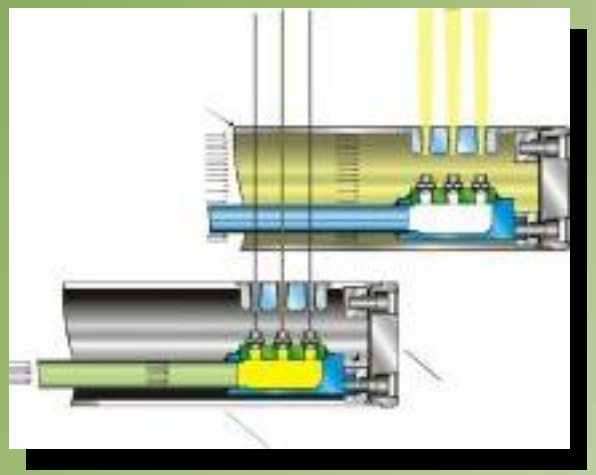
Penetration Depth vs. Linear Speed





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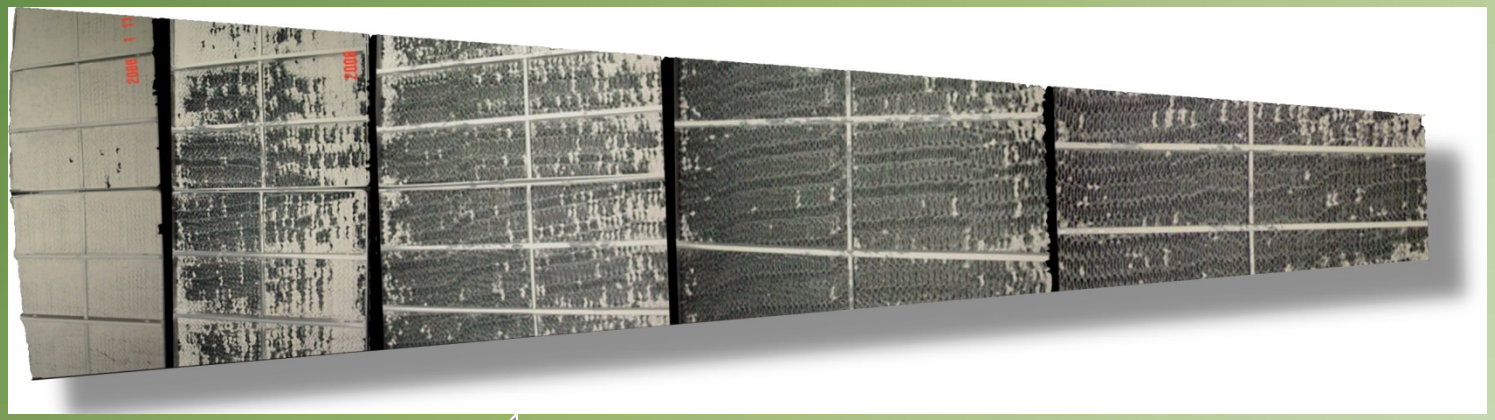
Fouling Distance from Hub



Outermost Baskets

Increasing Fouling

Innermost Baskets

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Patent Pending Process

The Breen Dynamic AH Cleaning Process:

- **Positions the Cleaning head at a fixed incremental position**
- **Controls the AH rotational speed to match the indexed position of the cleaning head**
- **Assures complete penetration of the cleaning media**
- **Eliminates AH Pressure Drop problems**

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BELEWS CREEK EXPERIENCE CLEANING SAH

ABS and Acid Deposition Mitigation

Scott Thomas, P.E.

Belews Creek, Duke Energy Carolinas

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History

- **Two Howden (Ljungström® Design) Vertical Shaft Regenerative air heaters (SAH)**
- **33VN - approx 45’ dia w/ 48 element (pie) sections - 21.5’ x 80”**
- **29” CS DU hot end w/ 41” Epoxy coated DU cold end**
- **Air Heater - shaft driven w/ Redundant VFD A/C motors**
- **Two Clyde Bergman Multible Fluid Retractable Soot-blowers (JetBlower®)**
  - **Top blower - Steam / LP (100psi/ water flow @ 175gpm) / HP Water (2900psi@ 36 gpm)**
  - **Bottom blower - Steam / HP Water (2900psi @ 36 gpm)**
- **HP Pump Skid – Delivers 72 gpm @2900 psi - positive displacement pump (one or two blower operation)**

Dual Media Nozzles

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Belews Creek SAH Fouling History

- **2003 – U1 SAH experience high dP w/o NH3 injection (acid deposition due to high Sulfur fuel and low inlet air temps)**
- **2004 – SAH fire investigation (root cause) identified issue with off line cleaning process**
- **2005 (July) – SAH soot-blower (Jetblower) control modified – Variable Speed Control for off-line water cleaning (algorithm also included for VSC operation while soot-blowing) – Excellent Off-line cleaning results**
- **2006 (Jan)- Lower NOx limits (BCU1 - 0.075 lb/MMBtu / BCU2 - 0.065 lb/MMBtu)– Resulting in Higher NH3 injection Rates w/ more ABS fouling**

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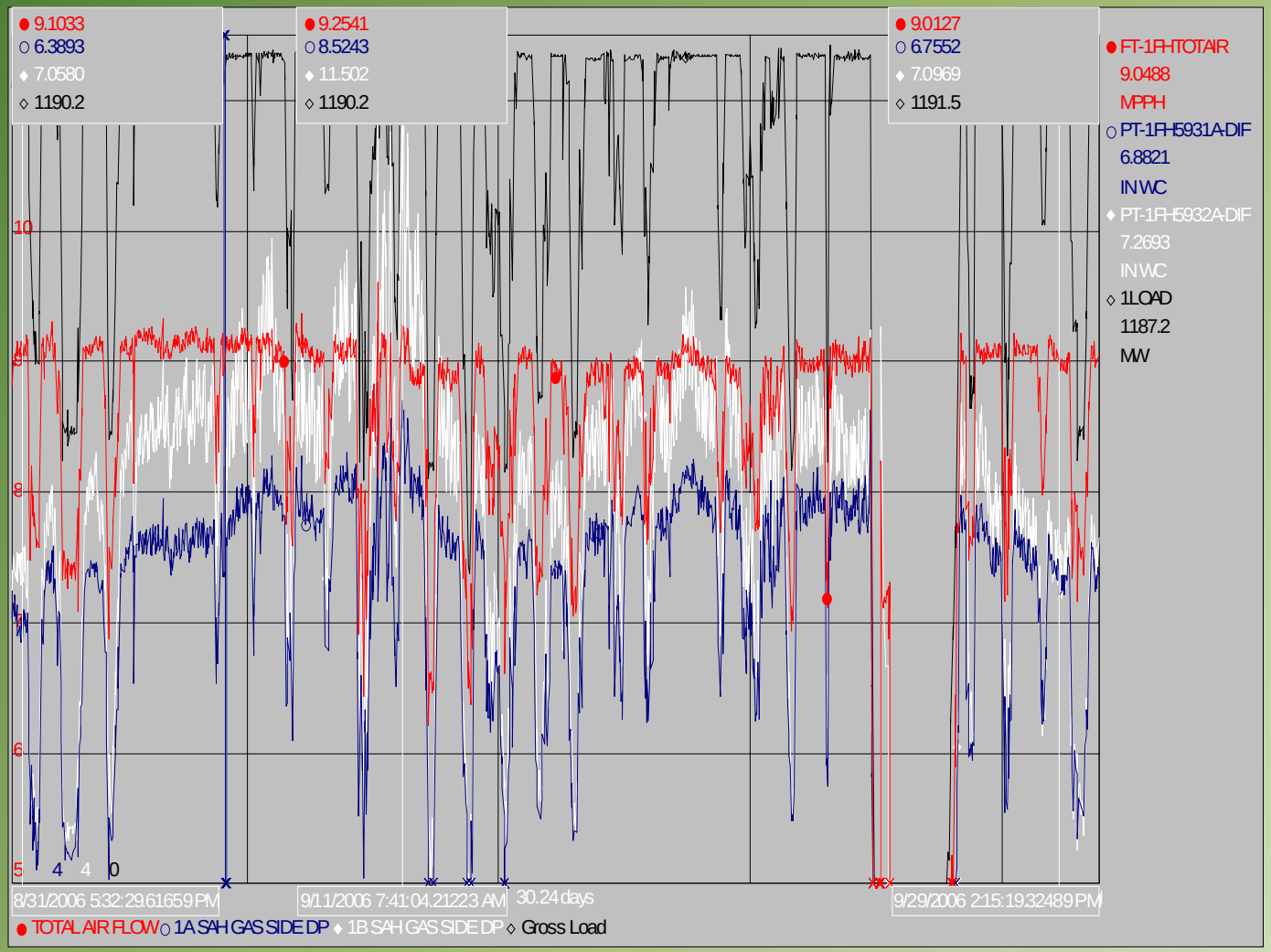
Belews Creek SAH History (cont')

- 2006 (March) – U2 prior to spring outage 2A SAH Test - 1m was cleaned on-line
- 2006 (April) – U2 SAH inspected during spring outage – no SAH issues noted – test area was visibly cleaner
- 2006 (Sept) – U1 dP increases - trial was initiated for LSBB Jetblower operation–) (air side dP dropped from 4.6% to 2.9%)

On-line Low Speed Steam Blow



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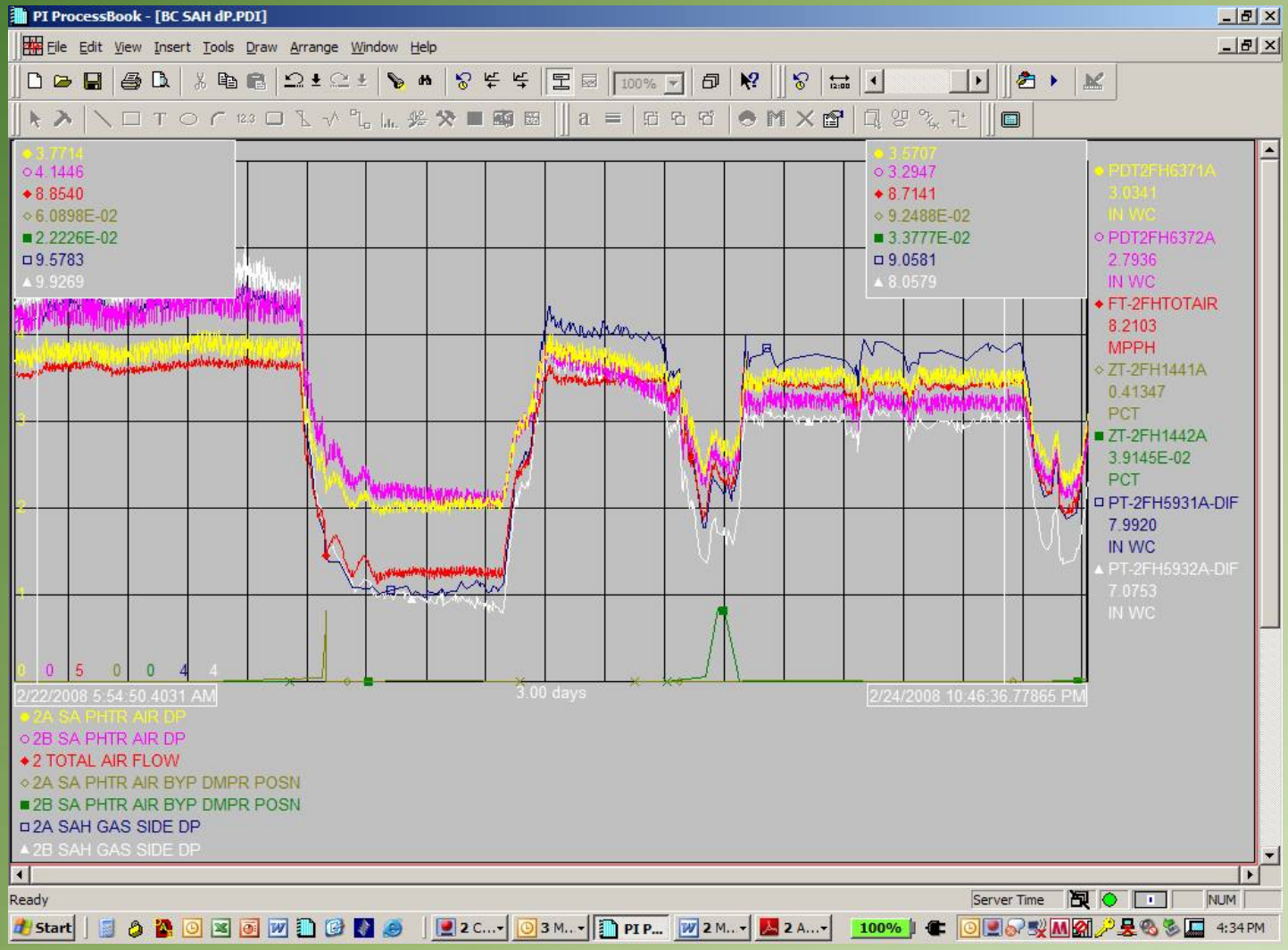
On-line HP Water Wash



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Belews Creek WPI – What was the Benefit

- **Eliminated two scheduled outages per year**
- **Reduced forced outage time – SAH cleaning not mandatory (36 hrs FO time - one shift to clean drain hoppers – 2 shifts to wash)**
- **Off-line cleaning is more efficient – 24 hrs vs 48 hrs**
- **Lowered CCE setpoint - reduced DGL**
- **Reduction in NOx – Raised NH3 slip**
- **Eliminated hot side element damage ($$)**

- **Summer 2008 – Noticed 2B Primary AH Pluggage Issues**

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CONCLUSIONS

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Conclusions

- De-NOx, SO_3 mitigation and Air Heater delta P are not stand alone issues,
- NH_3 Injection and SO_3 Mitigation can, and should, be controlled as a combined system,
- Advantages:
  - Improved NOx Reduction
  - Reduced chemical usage
  - Improved heat rate
  - Avoided Air Heater delta P

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Conclusions

- Chemical injection processes must be controlled and optimized
- Dynamic, low speed, air heater cleaning can provide a reliable insurance policy against disturbances in a tightly balanced chemical injection process.

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Thank You Questions

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